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Arrangement for measurement demodulation and modulation error measurement of a digitally modulated received signal

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The invention concerns and is based on an arrangement according to the preamble of the main claim.

Measuring arrangements of this type are known (ETSI Tdoc SMG2 829/99, Meyr, Moeneclaey, Fechtel: "Digital Communication Receivers", WILEY INC, New York, 1997). They are used for modulation error measurement on digitally modulated receive signals. For data transmission in modern digital transmission technology, so-called digital modulation modes which are known in many different variants, are used. The most frequently used modulation modes are the so-called PSK, QAM, MSK or FSK modulation methods. For data transmission, special transmit and receive filters are required at the transmitting and receiving ends, respectively, in order to achieve time intervals for the demodulation of the data, that are free of inter-symbol interference. For measurement purposes, special weighting filters have to be used in the receive path, instead of the receive filter.

Figure 1 shows a known filter arrangement that is suitable for this purpose. The PSK modulated measuring signal, for example, passes after frequency conversion, not shown, A/D conversion and, if required, digital mixing, to the input of the measuring arrangement as a complex baseband signal. Receive filtering in a receive filter (matched filter) initially takes place at this point, and in the following demodulator 2 signal errors such as mean frequency errors, initial phase errors, mean timing errors and the like are detected and eliminated. Furthermore, a symbol decision stage is provided in the demodulator 2, which generates the symbol samples of an ideal, reconstructed transmit signal from the error-free measuring signal, for example by quantisation of the IQ data, the phase or absolute value. The signal is then filtered by means of a reference filter 13. The reference filter 13 has the characteristic:

reference filter = TX filter* weighting filter.

(Here the symbol "*" is used as a convolution operator and signifies convolution of the filter pulse responses in the time domain; both in the time domain and in the frequency domain the filter design itself can be achieved analytically and with approximation methods).

In this case the TX filter is the pulse-shaping filter used at the transmitting end of the respective transmission system, the weighting filter is a filter that is specified according to the weighting standard. The input signal to be weighted in the weighting filter 11 is first delayed in a memory 9 and error-corrected in an error-correction stage 10 that is connected to the demodulator 2, and is then fed to the weighting filter 11. This weighting filter 11 is designed in accordance with the desired weighting function, for example in accordance with the ETSI specification. The ideal signal of the reference filter 13 and the weighted receive signal of the weighting filter is then passed on to a following evaluation circuit 4 for further error detection, and finally to a display circuit 5 in which, in addition to the detected numerical modulation errors, measuring or reference signals as well as error signals derived from them, are numerically or graphically displayed. For further error detection in the evaluation circuit 4, for example by comparing the two signals, further modulation errors, for example, error vector magnitude, magnitude error, phase error, respectively, are determined symbol-by-symbol or over a specific measurement period.

In the known arrangement, the original input signal has to be temporarily stored in a memory for later weighting filtering, and additional arithmetic operations are necessary for error correction of the original input signal prior to its weighting.

The object of the invention is to simplify an arrangement of this type with regard to construction and computing effort.

Based on an arrangement according to the preamble of the main claim, this object is achieved by its characterising features. Advantageous developments are revealed in the sub-claims.

In the arrangement according to the invention a buffer memory is superfluous, so are additional arithmetic operations for error correction. The corrected output signal of the demodulator is directly employed for weighting filtering.

The invention is explained in further detail below with the aid of an exemplary embodiment in Figure 2.

In the arrangement according to the invention in Figure 2, the input signal is again filtered in a receive filter 1 (RX filter) as is required by the following demodulator 2. The receive filter 1 can be designed, for example, so that ISI-free samples can be fed to the following demodulator 2. If a so-called Viterbi demodulator is used as demodulator, for example, this receive filter 1 is matched to its demodulation characteristics. After detection and compensation of specific signal errors in the demodulator 2, a symbol decision stage of the demodulator 2 determines the ideal symbol samples from the error-corrected measuring signal. After these ideal symbol samples have undergone pulse shaping, these are again fed to the evaluation circuit 4 via a reference filter 13 having the same characteristics as in the known arrangement in Figure 1.

In contrast to the arrangement shown in Fig. 1, the error-corrected measuring signal of the demodulator 2 is directly fed to a measuring filter 12 which has the following

characteristic or approximation, respectively, within the permissible measurement tolerance:

weighting filter = receive filter* measuring filter

In the arrangement according to the invention the desired weighting filter characteristic, which meets the ETSI specification, for example, is therefore obtained by the cascaded filter characteristics of the receive filter 1 and the measuring filter 12, thus making an additional buffer memory superfluous, and the additional arithmetic operations for error correction, as are necessary in the known arrangement are also superfluous. The already error-corrected output signal of the demodulator 2 is used for the weighting filtering. In this arrangement the measuring filter 12 can also be made more simple, since the filter function of the preceding receive filter is already taken into account in the weighting filtering. The output of the measuring filter 12 is again connected to the evaluation circuit 4, further evaluation being effected as in the known arrangement shown in Figure 1.